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"Intensify Industry by Double": How Environmental Policy can Foster Economic Densification

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1 ABSTRACT

The EU's goal to achieve "No Net Land Take" requires substantial reductions in land conversion by 2030. It also means that, from 2050 onwards, the total area covered by "buildings and infrastructure" cannot increase unless it is compensated for elsewhere. This, among other implications, forces a reconsideration of how a growing economy can be accommodated within finite spatial limits.

In this paper, we explore two projects that aim to revive and intensify existing industrial areas taking into account the fact that the redevelopment should be economically viable.

In 2017 the Sheffield School of Architecture was invited by Atelier Brussels to examine how industrial land in the metropolitan South-West could be used more efficiently. The project responded to a wider policy ambition: reconciling urban growth with the preservation of space for manufacturing, making economic activity visible in the public space, and supporting emerging circular-economy dynamics. Through an in-depth design investigation of five contrasting industrial sites – Bollinckx, Bempt, Paul Gilsonlaan, the Audi expansion zone, and Allnex – the team developed a systematic and transferable approach to unlocking latent capacity within existing economic estates. Their method demonstrates how build-up, build-out, and infill strategies, combined with shared-space configurations, multi-storey industrial typologies, and the reuse of irregular or underutilised spaces, can collectively double usable economic floor area without increasing land take. Applied across the cases, this method yielded more than a 200% rise in usable floor area, demonstrating the broader potential of spatial intensification within highly constrained urban-industrial environments.

Recently we applied a similar approach to an old industrial area to the east of Brussels. The site is partially situated in a flood prone area and is waiting for redevelopment. The method developed by SSoA was used to construct a real estate calculation model to estimate the potential return on investment. The case study consists currently of a small scale logistics sheds, between a small river and the Brussels' orbital ring road. Due to the potential flooding problems the river needs more space for water management, leaving less space for the logistics activities. The model starts from the shrinking footprint of the buildings, and aims to optimize the redevelopment by adding multiple storeys. In this case the logistic activities were organized on the ground floor, with other economic activities, parking and long term private storage on the upper floor. To get to a viable project, the floor surface was tripled.

Keywords: economic redevelopment, intensification, multi-storey industrial building, No Net Land Take, urban planning

2 A PERFECT STORM: A GROWING ECONOMY WITHIN SPATIAL CONSTRAINTS

Several ongoing transitions are simultaneously pushing up the spatial demand of the European economy at a time when the possibilities for outward expansion are becoming increasingly constrained. This coincidence of upward demand and tightening land conditions constitutes a kind of perfect storm for spatial planning: the economy requires more space at the moment when land conversion becomes increasingly difficult to justify.

First, open strategic autonomy has gained importance in European industrial and trade policy since the 2020pandemic and Russia's invasion of Ukraine exposed vulnerabilities in global value chains and the EU's dependence on external production capacity. In its New Industrial Strategy, the European Commission stresses that Europe must become less dependent on others for critical technologies, raw materials, food, infrastructure and security (European Commission, 2020). This ambition has since been operationalised through the Green Deal Industrial Plan (2023) and the Net Zero Industry Act (2023) which accelerate the deployment of battery manufacturing, heat pumps, electrolysers, network technology, renewable energy equipment and CCS technologies – all of which require significant land (ESPON, 2023).

Second, the transition towards a circular economy introduces new spatial functions into metropolitan production systems. Circular consumption and production models rely on repair, reverse logistics, urban

mining, recycling, storage and sorting activities, most of which require additional logistics floor area and proximity to consumption centres in order to reduce transport distances (ESPON, 2019). These processes are therefore not easily externalised to distant industrial regions, but compete for space within the existing urban and industrial fabric. The Critical Raw Materials Act adds to this demand by requiring that by 2030 at least 10% of annual consumption be extracted within the EU and 40% be processed in the EU, further expanding the need for physical sites for extraction, processing, storage and logistics.

A third driver concerns the spatial footprint of the post-carbon energy system. Electrification of industry and mobility, combined with the roll-out of renewable energy production and storage, requires substantially more space than the former fossil-based system in which critical parts of extraction and processing occurred outside the EU (Perpiña Castillo et al., 2024). Solar farms, wind parks, hydrogen storage, CCS terminals and mining and recycling facilities exert spatial claims – often in rural areas with low artificialisation (Geronnez et al., 2024).

However, this upward pressure on economic land demand coincides with a structural tightening on the supply side of land. Environmental and climate legislation increasingly restricts the conversion of open land, but also generates new spatial claims for soil protection, ecosystem restoration, water retention and climate adaptation. The European target of achieving No Net Land Take by 2050aims to halt the net conversion of open land into built surfaces, implying that new developments must be compensated elsewhere or avoided altogether (European Commission, 2016). The Soil Monitoring Law introduces binding rules for soil health, while the Nature Restoration Law sets explicit targets for ecological restoration.Moreover, climate adaptation policies restrict the amount of developable land available for economic activities – even within areas legally designated for economic use. Water safety and drought management require additional space for riverbeds, wetlands and infiltration zones; climate adaptation encourages de-sealing and the expansion of green–blue networks.

Finally, another mechanism further tightens the supply side: the social acceptability of production facilities is declining (ESPON, 2023). As Peleman (2018) argues, due to automation and sectoral restructuring, the spatial footprint of economic activities is increasingly decoupling from visible positive externalities such as employment, status or territorial identity. Industrial areas therefore contribute less to the symbolic and spatial capital of territories, while their environmental and landscape burdens remain tangible. As a result, local willingness to host new production sites or accept additional soil sealing is diminishing, even when such facilities are desirable from a regional or national perspective.

In highly urbanised regions, these combined dynamics lead to what Geronnez et al.(2025) describe as territorial saturation: the land system loses its capacity to accommodate additional activities through expansion alone, as both ecological imperatives and competing societal needs occupy the remaining spatial slack. Under such conditions, the classical planning response of outward extension becomes increasingly infeasible.

Taken together, these trends create a situation in which demand is structurally pushed upward while supply is structurally tightened.

3 "MADE IN BRUSSELS": DOUBLING INDUSTRIAL SURFACE AREA

Several strategies have been advanced in recent years to sustain productive capacity within finite territorial envelopes.These include the functional reconversion of obsolete industrial fabrics (Furlan, 2022); the vertical intensification of productive floor area; the sharing of logistics and service infrastructure across firms; the co-location of compatible economic functions; and the deployment of circular-economy models that retain added value within metropolitan space (Geronnez et. al., 2025). Other approaches involve the redesign or reallocation of access infrastructure to reduce circulation footprints, and the development of multi-storey industrial typologies that combine production, storage and ancillary services on constrained sites. Together, such strategies shift the emphasis from land procurement to land productivity: the objective becomes not to expand industrial land, but to extract more economic, social and circular value from the land already designated for productive use.

3.1 The 2017 Made in Brussels Live project

The Made in Brussels project provides a concrete illustration of such a strategic shift. Commissioned as part of the 2017 Atelier Brussels initiative, students of the Sheffield School of Architecture (SSoA) were asked to explore how five existing yet outdated industrial estates[1] in Brussels' southwestern metropolitan belt could be revived and intensified to accommodate new economic activity without displacing industry out of the city. The brief explicitly framed the retention of productive activities within the city as desirable for reasons of employment – particularly to preserve activities relying on low- and medium-skilled labour – and city servicing. At the same time, the challenge was to secure the highest possible return in terms of added value, urban servicing and employment outcomes, among other improvements.

Rather than producing a conventional masterplan or zoning proposal, the project operated as a live urban experiment that tested how architectural and spatial design methods could reveal latent productive capacity within the existing industrial fabric. Five contrasting sites were selected to represent different typologies of metropolitan industry – from densely built metal workshops to pavilion-style business parks and logistics sheds – allowing the project to probe a broad range of spatial, infrastructural and regulatory conditions.

3.2 Four strategies for industrial intensification

Before engaging in spatial design, the students conducted a spatial analysis of the existing industrial fabric across the five sites. This spatial reading revealed that a substantial share of land within functioning industrial estates was occupied by low-intensity uses such as oversized manoeuvring yards, perimeter safety buffers, fenced circulation corridors and lightly used paved yards. These configurations resulted in high land consumption per unit of productive floor area and limited opportunities for firms to expand within their plots.

More importantly, the analysis revealed a mismatch between the spatial organisation of these old industrial estates (with dispersed pavilion buildings, fragmented parcels, and over-dimensioned setbacks) and the operational needs of contemporary production, which depends on the co-location of firms to reduce transport and handling, shared infrastructure, shorter material flows, flexible floor area for changing production cycles etc. Such configurations are difficult to realise within estates designed for single tenants, segregated parcels and extensive surface parking.

These spatial conditions also meant that a series of residual spaces – perimeter buffers, manoeuvring yards and internal voids – could be reactivated as spatial reservoirs for intensification. This provided the basis for three types of design strategies:

(1) Build-up, by adding additional floors above existing footprints

(2) Build-out, by extending volumes into underused perimeter zones or internal yards; and

(3) Infill, by inserting new volumes into the internal voids typical of pavilion-style layouts.

In addition to these physical strategies, the project explored shared servicing strategies, in which circulation and logistics infrastructure (ramps, yards, loading bays, waste handling or storage) could be shared among firms to reduce duplication and free up surface area for productive activity. These strategies underscored that industrial land is not merely an assemblage of occupied and vacant parcels, but a spatial system organised through rules of access, servicing and logistics that can be redesigned to unlock additional productive capacity.

3.3 The intensification flow diagram

Beyond generating site-specific design proposals, however, the project was able to synthetisize the above findings into a flow diagram that articulates a transferable sequence for intensifying industrial land. The diagram links the spatial reading of an industrial estate to a series of decision points that establish how additional productive floor area can be accommodated within a given site without increasing land take.

Rather than prescribing a single design solution, the diagram tests different intensification options in a structured order. It first assesses whether additional floor area can be achieved by adding storeys (build-up), then whether ground-level expansion is feasible within residual or perimeter spaces (build-out), and finally whether voids within the estate can support new volumes (infill). If these strategies alone do not produce

[1] The five sites included: (1)Bollinckx in Anderlecht; (2) Bempt in Forest, (3) Paul Gilsonlaan in Drogenbos; (4) the Audi expansion zone in Drogenbos; and (5) Allnex in Drogenbos

sufficient floor area, the diagram activates a fourth lever: shared servicing, where logistics, yards, ramps, parking or storage are reorganised collectively across firms to free up additional productive space.

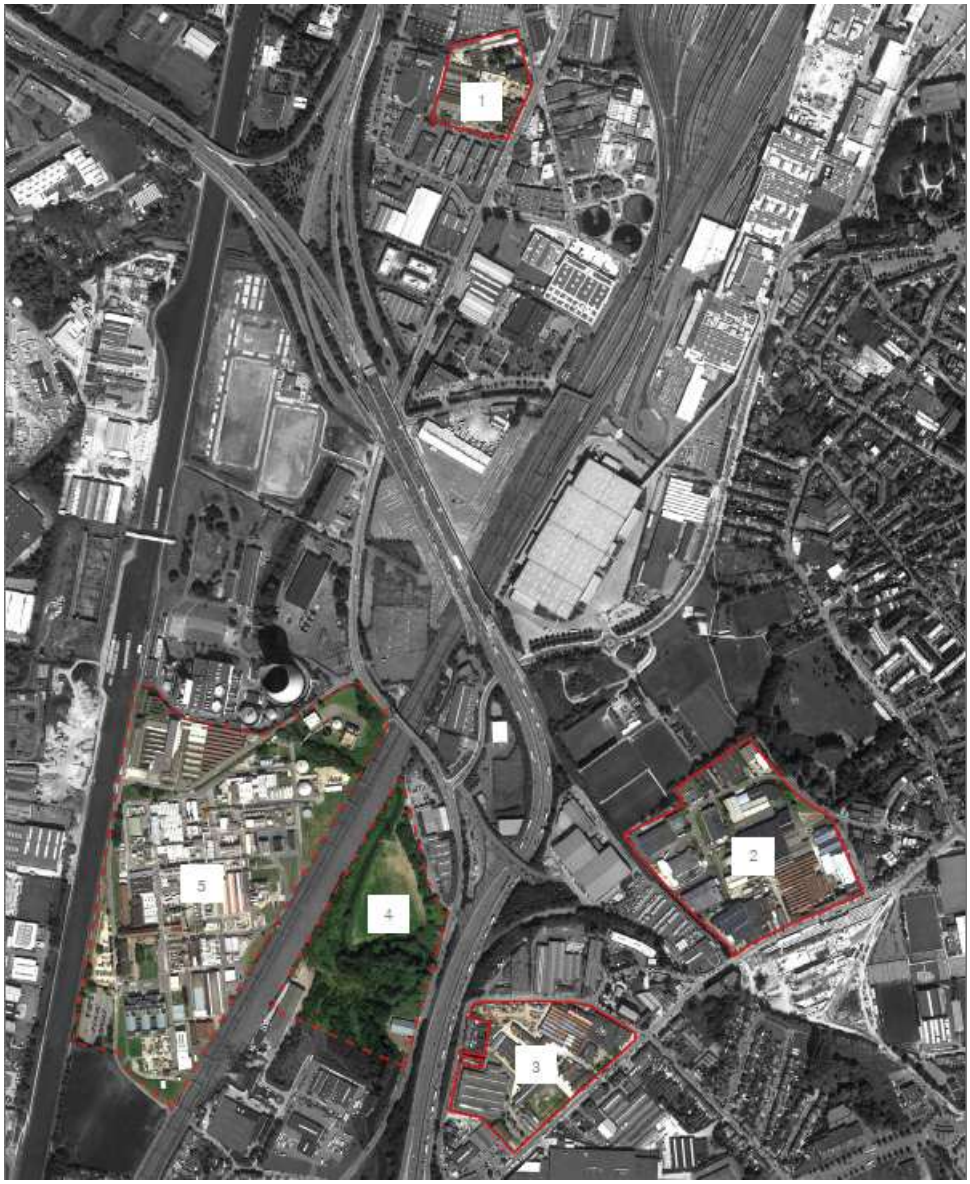

Figure 1: The five sites selected for the 2017 Brussels Live Project. Source: Made in Brussels (2017)

While developed within a design-studio environment, the value of the flow diagram lies in its generalisability. It provides metropolitan planners, public land agencies and private developers with a systematic method for assessing the intensification potential of industrial estates, including those that differ in sectoral composition, ownership structure or regulatory context. In doing so, it shows that doubling industrial surface area is not only a spatially plausible outcome for exemplary cases, but a methodologically reproducible approach for dealing with scarce industrial land under conditions of territorial constraint.

3.4 Policy relevance

Applying the intensification sequence across the five sites consistently yielded increases of more than 200% in usable economic floor area, without expanding the land take footprint. These figures are indicative rather than predictive – the proposals were not cost-engineered nor tested against permitting– , but they demonstrate that substantial additions of productive floor area are spatially feasible within existing industrial estates under realistic urban constraints.

More generally, the project illustrated that design methods can uncover forms of latent productive capacity that remain invisible within conventional planning frameworks, which tend to categorise industrial land primarily by zoning, parcelisation and functional designation rather than by spatial performance. In this

sense, the project reframed metropolitan industrial estates as spatial assets rather than planning liabilities, and positioned intensification as an alternative to both relocation and net land take.

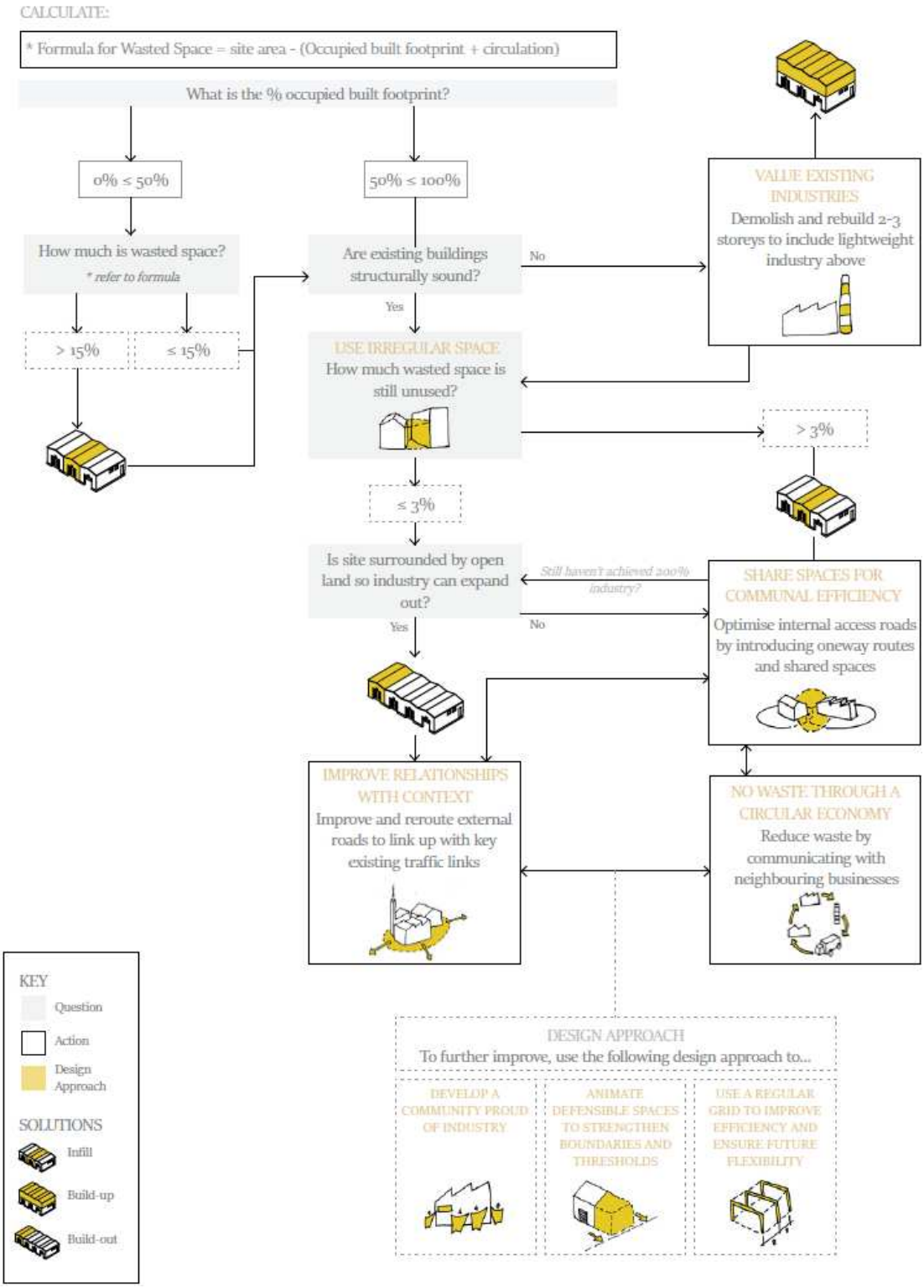

Figure 2: The intensification flow diagram. Source: Made in Brussels (2017)

4 TESTING THE THEORY: IS DOUBLING EVEN VIABLE?

The logical next question is whether such spatially plausible intensification can also prove viable under real development conditions. While the previous sections have demonstrated that doubling industrial floor area is conceptually and spatially feasible within existing estates, these insights emerged largely from design-driven investigations unconstrained by market dynamics, construction costs, regulatory sequencing or ecological requirements. In practice, however, metropolitan redevelopment occurs under a widening set of constraints.

Sites must accommodate more surface area within a given space while supporting the co-location of economic, residential, recreational and service functions – all within spatial regimes that historically separated such uses rather than mixed them. More importantly however, climate adaptation and soil policies require the he reduction of sealed surfaces and the reservation of space for water retention, floodplain restoration and blue–green networks.

Under such conditions, classical intensification strategies that build-out or fill-in often fall short. If the residual surfacethat previously enabled horizontal expansion – in between spaces, yards, setbacks and manoeuvring zones –, is increasingly reassigned to ecological, hydrological or public-space functions and is thus no longer available for development, vertical intensification therefore becomes the primary remaining lever: productive uses must be stacked rather than spread. Yet build-up strategies introducestructural and logistical complexities and thus higher construction costs, which in turn require higher revenues or new value models to close the business case. The viability question then becomes whether such vertical stacking can be made economically investable under metropolitan market conditions.

4.1 The case of Zaventem Fabriekstraat

We were able to test this question in the context of a recent consultancy on improving spatial performance in the Brussels Airport region, commissioned by the Flemish Department of Environment and Spatial Develompent. The assignment examined how municipalities in the airport noise corridor could accommodate economic and residential programmes without increasing exposure to aviation noise, while at the same time improving spatial cohesion and aligning redevelopment with climate and soil policies. This required exploring options for more productive land use, mixed-use intensification and selective relocation of sensitive functions.

Within this broader study, the Fabriekstraat industrial estate in Zaventem was selected as one of the strategic test cases. The site borders the residential centre of Zaventem and is located at the lowest point of the Woluwe valley, resulting in both pluvial and fluvial flood exposure. It consists almost entirely of sealed soil and interrupts the ecological continuity of the broader valley green structure, thereby creating a clear task to restore or re-establish green–blue connections across the site. In addition, the combination of airport, rail and road noise places it within multiple strategic noise contours where new housing is generally deemed undesirable without mitigation. At the same time, the site is well connected: it is serviced by an important public transport corridor, lies near Zaventem train station and the Brussels–Leuven cycle highway, and already hosts productive activities with significant surface demands.

These conditions made Fabriekstraat a representative stress test for metropolitan industrial intensification: any strategy to retain or expand productive capacity would have to contend simultaneously with water management, de-sealing, ecological continuity, logistics accessibility and also noise-sensitive programme allocation.

To explore spatial intensification on the site, three design scenarios were developed. All three tested a different spatial logic for combining economic, residential and ecological functions under severe noise and hydrological constraints. In the first scenario, a south–north gradient was introduced ranging from housing to mixed-use to vertically stacked economic functions. Housing was placed along the southern edge, outside the 50 dB Lden aircraft noise contour, while the central part of the site accommodated mixed-use buildings combining economic and residential programmes in roughly equal proportions. Toward the ring road, the programme shifted to predominantly economic uses with a higher intensity, resulting in a scenario where the economic and residential programmes were relatively balanced in gross floor area. A substantial green buffer was introduced along the R0 to act as a noise screen.

The second scenario maintained the ambition of mixing economic and residential programmes while strengthening the ecological and hydrological functioning of the Woluwe valley. The valley was widened into a continuous blue–green corridor, logistics access and manoeuvring space were consolidated, and large sealed surfaces were de-paved to create floodable open space. Here, productive functions were clustered along the ring road while the mixed-use band in the centre of the site carried both living and working programmes at comparable levels, and housing increased slightly compared to Scenario 1. The spatial organisation was clearer and the overall residential programme moderately larger, reflecting the improved environmental conditions created by the blue–green corridor.


Figure 3: Fabriekstraat project area, Figure 4: Pluvial flood risk.

Figure 5: Aircraft noise, Figure 6: Road traffic noise.


Figure 7: Protected heritage, Figure 8: Green structure.

The third scenario departed more drastically from the existing condition by avoiding development in the water-sensitive valley altogether and placing the economic programme as a buffer between the ring road and the residential core. In this scenario, housing moved closer to the town centre and the share of pure economic floor area increased relative to the mixed-use portion. This strategy enabled the creation of a wide green buffer along the R0 – potentially with sculpted topography – and tested whether productive volumes could

shield the town from road traffic noise. Municipal feedback considered this spatial logic the most promising due to its hydrological robustness and urban legibility, although noise-related limitations for new housing remained.

	Scenario 1	Scenario 2	Scenario 3
Economic programme	16.718 m²	15.976m²	~13.483 m²
Residential programme	14.704 m²	20.178 m²	~10.690 m²
Ratio residential-economic	1:1,14	1:0,79	1:1.26
Total costs	€232M	€247,2M	€282M
Total revenues	€94,7M	€107,2M	€79.9M
Result	-€137,3M	-€140M	-€202,3M

Table 1.

Spatially, the three scenarios showed that higher productive capacity within the existing perimeter is possible when logistics is reorganised and ecological continuity restored. Financial modelling, however, demonstrated that each scenario resulted in substantial deficits under current market conditions. This prompted a second analytical step in which the site was subdivided into functional sub-areas to introduce greater flexibility and tailoring in the financial models. By disentangling the economic programme from housing, water and public-space components, it became possible to test what economic development could achieve on its own terms – technically, operationally and financially. Within this decomposition, the western strip along the ring road – Zone West – displayed the highest carrying capacity for productive uses at higher intensities and is therefore examined in the following section.

4.2 Zone West: building up economic surface

Within Zone West, two stacking alternatives were subsequently developed that both tested whether productive capacity could be doubled within the existing perimeter while halving the footprint and reducing sealed surfaces. In both configurations, productive activities were distributed vertically up to 30m in height, with consolidated servicing and manoeuvring zones placed along the western façade facing the R0. This organisational strategy allowed the building to internalise logistics, parking and circulation functions that would otherwise consume surface area, while freeing up the eastern side toward the valley for water retention, de-sealing and ecological connectivity. Both alternatives therefore demonstrated that spatial intensification and climate adaptation need not be contradictory objectives, provided access and logistics are restructured in three dimensions rather than two.

The first alternative explored a metropolitan productive programme composed of logistics, small and medium-sized enterprise (SME) spaces, office-like functions and self-storage. These activities were selected not only for their compatibility with the site's multimodal accessibility but also for their capacity to support higher rental levels and diversified revenue streams. The configuration doubled total floor area from approximately 25,000 m² today to around 54,200 m² in this first alternative, while reducing the footprint from 27,930 m² to 14,656 m². The economic performance was strongly driven by self-storage, which was expected to achieve high unit revenues (~€8,200/m²) and served as a cross-subsidising component for the remaining productive uses. The alternativewas expected to produce a total surplus of more than €18 million, indicating that a vertically stacked productive building can be made investable when the programme incorporates higher-yield functions alongside industrial uses, thereby increasing average revenue levels and supporting the additional CAPEX of multi-storey structures. The resulting building type resembles emerging urban-industrial architectures in other European metropolitan regions, where productive uses are increasingly embedded within high-value, multi-tenant ecosystems rather than isolated in single-storey sheds.

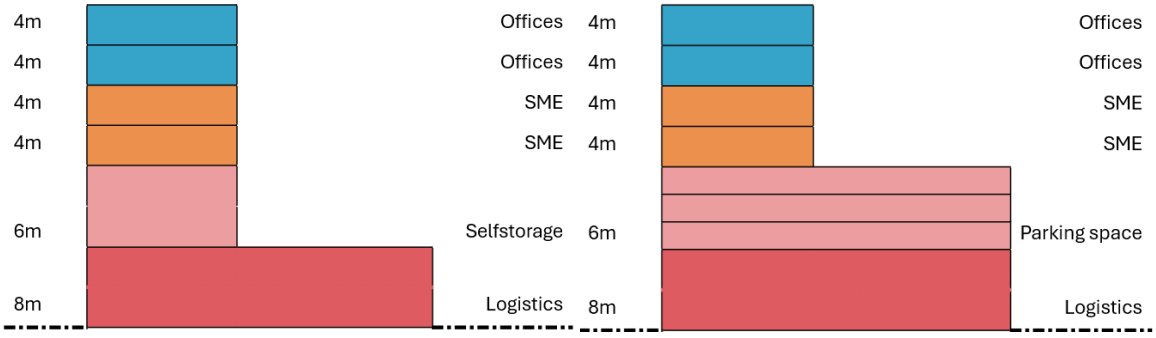

Figure 9: Zone West – Alternative 1, Figure 10: Zone West – Alternative 2.

The second alternative tested a more conservative programme by allocating large portions of the building to multi-lever car park in addition to productive uses. Although the footprint reduction was identical to the previous scenario, the vertical build-up was even more pronounced: total floor area increased from roughly 25,000 m² to approximately 85,000 m², thereby more than tripling productive capacity within the same perimeter. Economically, however, the scenario performed less strongly due to the lower unit revenues associated with parking (~€ 950/m²), resulting in a narrow surplus of approximately € 0.4 million. While effectively break-even, the second alternative nevertheless demonstrated several important insights: first, that mobility-related programme can be structurally internalised within the productive envelope rather than consuming surface area; second, that footprint reduction and intensification do not necessarily depend on high-yield functions; and third, that vertical stacking remains technically feasible even under lower market rents, albeit without generating significant surplus value.

Taken together, the two alternatives illustrate that vertical intensification of productive uses is spatially and structurally feasible under metropolitan conditions, but that financial viability is highly sensitive to programme composition, revenue logic and the ability to incorporate functions with higher value profiles. In other words, the question is no longer simply whether productive capacity can be doubled, but under what economic and institutional conditions such doubling becomes financeable.

5 CONCLUSION

The cases discussed in this paper demonstrate that the ambition to "double" industrial capacity within a fixed perimeter is not merely a speculative design exercise. The Sheffield School of Architecture framework of build-up, build-out, infill and shared servicing strategies proved transferable across contrasting metropolitan conditions and confirmed that latent productive capacity in existing estates can be mobilised to structurally increase usable floor area without additional land take.

Yet, the SSoA-framework presupposes a relative freedom from external constraints. The ability to reorganise access, servicing and circulation in three dimensions presumes that residual space remains available for manoeuvring, buffering or shared logistics. In more metropolitan contexts, this residual space is now increasingly claimed by non-economic objectives that are no longer peripheral but central to planning regimes. Climate adaptation, soil improvement, water retention and green–blue continuity introduce binding claims on footprint, permeability and morphology – as illustrated in Zaventem, where flood exposure and green-structure restoration absorbed much of the former expansion space. Doubling productive capacity thus requires not only vertical stacking ("build-up") but a simultaneous reduction of sealed surfaces and a shrinking of the operational footprint.

These non-economic objectives can, however, act as productive constraints rather than absolute limits. In the case of Zaventem, flood mitigation and ecological continuity functioned as design drivers for a new three-dimensional organisation of logistics and productive space. The result was not simply a more ecological project, but one in which productive capacity could be multiplied within a smaller sealed surface. In this sense, the ecological turn of planning can operate as a push factor for industrial innovation rather than a brake.

The question that remains is whether such climate-adaptedintensification can also be made economically viable. The answer is not universal but conditional: viability depends less on the spatial configuration than on the composition of the programme. The Brussels cases show that multi-storey productive buildings can become investable when higher-revenue functions are incorporated to cross-subsidise productive uses; they break even under conservative revenue profiles and perform strongly under diversified ones. Complex vertical industrial architectures therefore appear not only spatially compatible with climate-adapted planning regimes, but economically plausible within metropolitan property markets – provided that programme composition and value models evolve accordingly.

In sum, metropolitan reindustrialisation under "no net land take" conditions is not only conceivable, but actionable. It requires a combined shift in design, planning and development practice: from land consumption to land productivity and from orizontal to vertical planning logics. The empirical horizon now moves from proving feasibility to scaling and institutionalisation.

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